Space Weather Technical Forecast

Issued on Wednesday, 16 August 2023 at 01:29 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Slight Chance of G1/Minor Geomagnetic Storm conditions on Day 1 and 2 (16th and 17th). Chance of R1/Minor Radio Blackouts throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity, as measured at GOES16, has been Low over the past 24 hours, with the peak flare a C4.1 event at 15/0657 UTC from AR3395 near the northwestern horizon.

There are now ten sunspot regions on the disc, including three small unnumbered unipolar regions in the eastern solar hemisphere. AR3403 (Dai/Beta) approaching the Earth-Sun line in the northern hemisphere appears to be the most notable sunspot group with the numerous small spots now consolidated into larger lead and trailer penumbra. A few small intermediate spots remain with ongoing spreading and areal growth. AR3405 (Eso/Beta) in the far northeast appears to contain a fairly simple magnetic configuration despite its moderate size with no apparent change in appearance since the previous assessment. Newly numbered AR3407 (Dso/Beta) in the southeast has grown rapidly, with fairly strong umbra associated with both lead and trailer spots. No significant flares have been observed from this region yet, but remains an area of interest, especially if current development trends continue.

A number of Coronal Mass Ejections (CMEs) have been noted on available coronagraph imagery in the past 24 hours, however almost all appear to be on the limb or far-sided events. Late in the period a filament lifted off from a region around S22E12 at 15/2200 UTC, however, there is insufficient coronagraph imagery at present to determine if an Earth-directed CME has occurred. As a result no Earth-bound CMEs feature during the period.

Solar Wind / Geomagnetic Activity: The solar wind, as recorded by ACE and DSCOVR at L1, was characterized by an ongoing slow solar wind regime, but with some late-period signs of an imminent fast wind.

The solar wind speed showed a falling trend within Background levels - from 320 to 290km/s. The solar wind density was on an increasing, then steady trend with a peak density of 13ppcc (above average) at 15/2026 UTC. The IMF while initially weak and below 5nT, increased to peak at 7nT at 15/1717 UTC before weakening slightly. The north-south component of the field varied weakly for much of the period, but was mainly anti-aligned with Earth's from around 15/1415 UTC. The phi angle was largely negative (towards the Sun) but switched to a positive (away from the Sun) sector from around 15/2045 UTC indicating the onset of a connection to a positive polarity high-speed stream (CH33/+).

The net result of the above solar wind parameters was for Quiet (Kp 0-2) geomagnetic indices throughout.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux was at Background levels.

GOES16 high energy (greater than 2MeV) electron flux varied between Normal Background and Moderate levels with the diurnal cycle, peaking 899pfu at 15/1720 UTC. The associated 24-hour integrated fluence remained below Active (1e8 integrated pfu) on a decreasing trend reaching

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2.23e7 integrated pfu at 16/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is currently Low, however there is a daily Chance of Moderate activity, with the regions most likely to produce significant flares being AR3403, AR3405 and AR3407.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs currently in the forecast. There are up to two fast wind streams due in the period, respectively CH33/+ on Day 1 (16th) which will likely be more geo-effective if it manifests, and then CH35/-, which is perhaps most likely on Day 2 (17th). Initially Quiet geomagnetic conditions should become occasionally Unsettled to Active with a Slight Chance of isolated G1/Minor Storm intervals on Day 1 and 2, but reducing later in the period to likely leave more reliably Quiet conditions.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is expected to persist at Background.

High energy electron flux (greater than 2MeV) is forecast to continue varying between Background and Moderate levels at first, but with a degree of suppression at GEO expected through midweek in the fast wind regime(s). An overall and increasing Chance of Active electron fluence is indicated for late this UTC week, with an extremely low risk prior to this.

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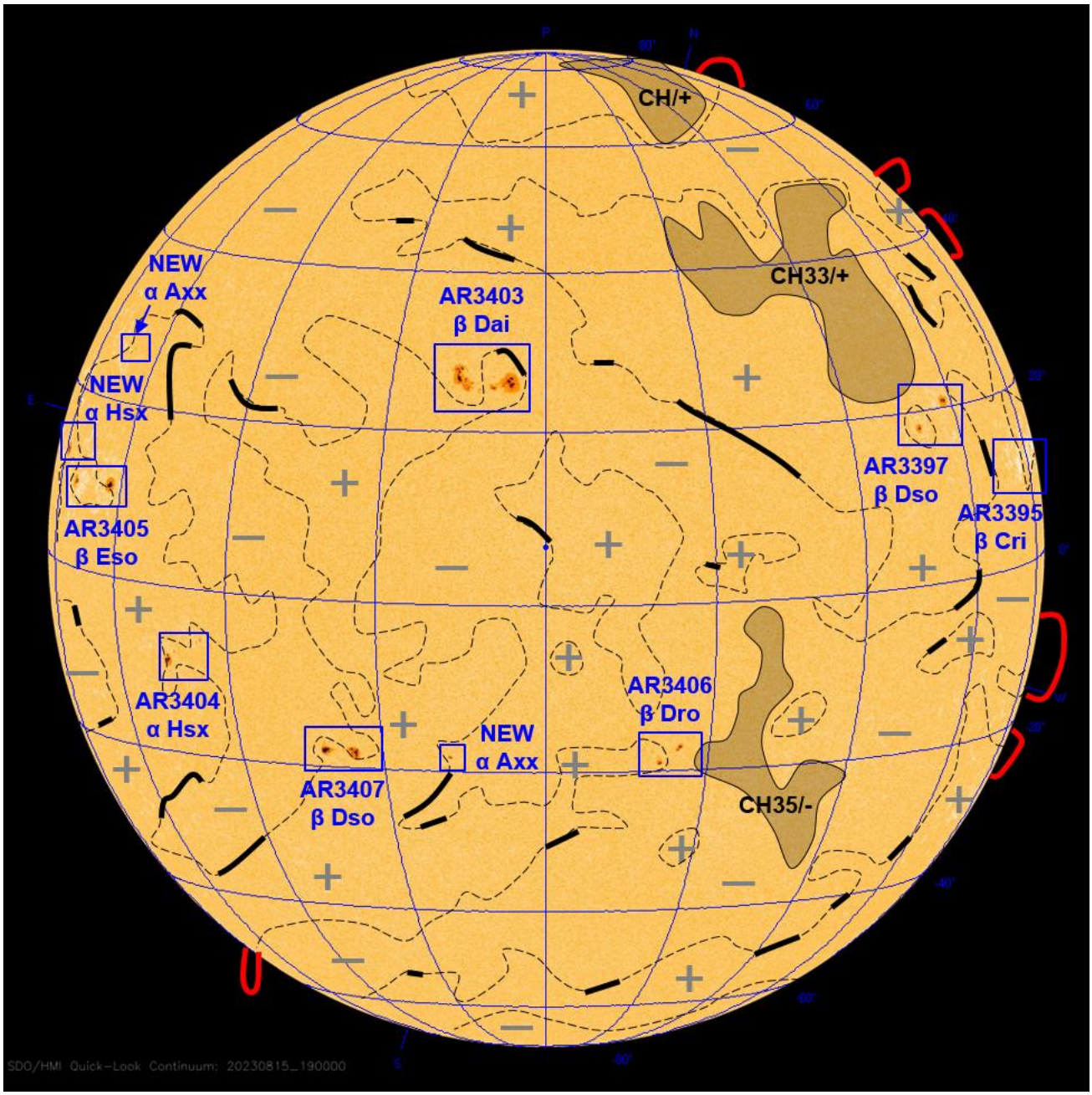
Figure 1. Solar Analysis Valid 15/1900 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are no Earth-directed CMEs currently in the forecast. Late in the UTC day on 15th August a filament lifted off from a region around S22E12, however, there is insufficient coronagraph imagery at present to determine if an Earth-directed CME has occurred.

Current slow-ambient solar wind conditions are likely to undergo an increase from CH33/+ during the next 24 hours. STEREO A has crossed the Sun-Earth line to again lead Earth in terms of angle, however it has a closer orbital radius of 0.95AU that means that it is estimated to provide around a five-hour or so lead time by virtue of the nature of the Parker Spiral. Indications were of a SSBC having occurred here at 15/0900UTC, with the phi angle of the IMF having switched to a positive (away from Sun) direction. The phi angle at L1 appears to have switched to a positive direction around 15/2045 UTC, slightly later than anticipated but other parameters such as density and wind speed tentatively support the imminent onset of the high-speed stream from CH33/+.

MOSWOC Enlil appears to be modelling the onset of CH35/- in the southern hemisphere anomalously early, with the model appearing to generate a high-speed stream from an area of weak fields currently in the west-centre disc from below the ecliptic. Any indication of a northern hemispheric high-speed stream from CH33/+ is currently slated for the 17th August (Day 2).

The duration of any fast wind from CH33/+ at Earth is expected to be relatively short, perhaps only 24 hours, as CH35/- becomes dominant. The reason for the higher confidence arises from its position straddling the solar equator (via its northern promontory portion). This is of the wrong polarity to generate a significant risk of G1/Minor Storm conditions given the time of year, however it does serve to slightly prolong the small risk from CH33/+ before it.

Initially Quiet geomagnetic conditions should become occasionally Unsettled to Active with a Slight Chance of isolated G1/Minor Storm intervals on Day 1 and 2 (16th and 17th), but reducing later in the period to likely leave more reliably Quiet conditions.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	15	5	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections - Nil

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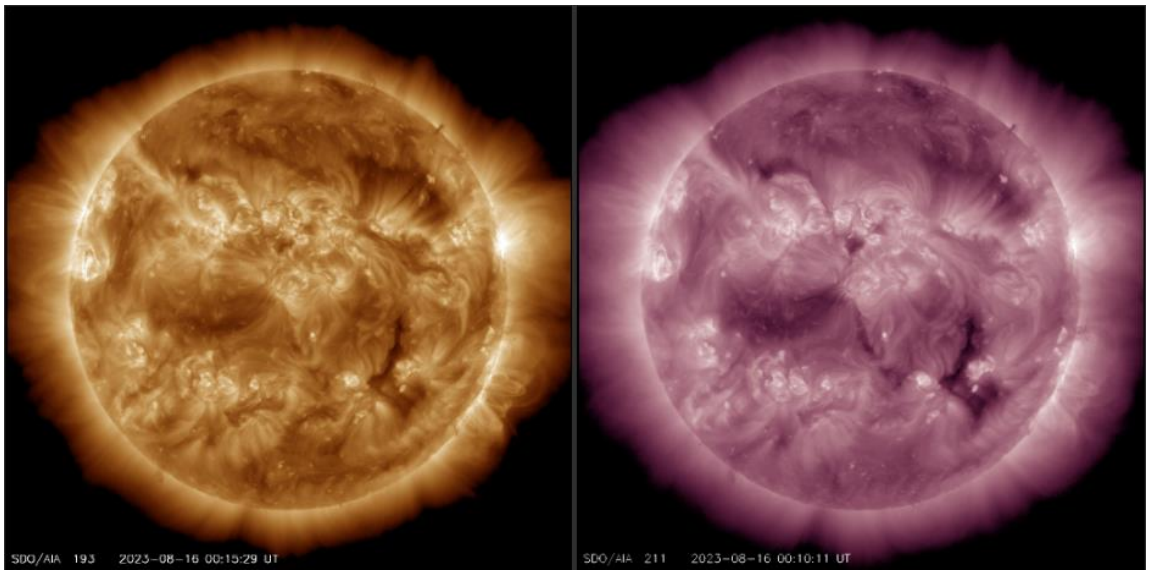
Figure 2: SDO aia 193 (left) and 211 (right) indicating coronal holes on northern (CH33/+) and southern (CH35/-) disc



Radio Blackouts - X-Ray Flares:

Solar activity is currently Low, however there is a daily Chance of Moderate activity, with the regions most likely to produce significant flares being AR3403, AR3405 and AR3407.

AR3403 (Dai/Beta) near the Earth-Sun line in the northern hemisphere continues to grow, both in size and longitudinal extent. A moderately large asymmetric trailer spot, along with some small, intermediate spot proliferation indicates some magnetic complexity that could result in a notable flare. AR3405 (Eso/Beta) near the northeastern limb appears to be separate from an Hsx spot to its northeast and appears to contain a fairly simple magnetic configuration despite its moderate size, with little or no development seen in the past 24 hours. Newly numbered AR3407 (Dso/Beta) in the southeast is of interest and has developed the most in the period. It has fairly strong umbra associated with both lead and trailer spots, but contains no intermediate spots of note at present. No significant flares have been observed from this region yet, but remains an area of interest, especially if current development trends continue.

Regarding the balance of sunspot group numbers two groups leave the disc in the coming days (AR3395 and AR3397), meanwhile there are signs that after a hiatus of a couple of days, further regions may arrive over the eastern limb to mitigate. Overall therefore, the flare risk is held constant.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	35	35	35	35
Very Active	R3 to R5 X Class	No	2	2	2	2

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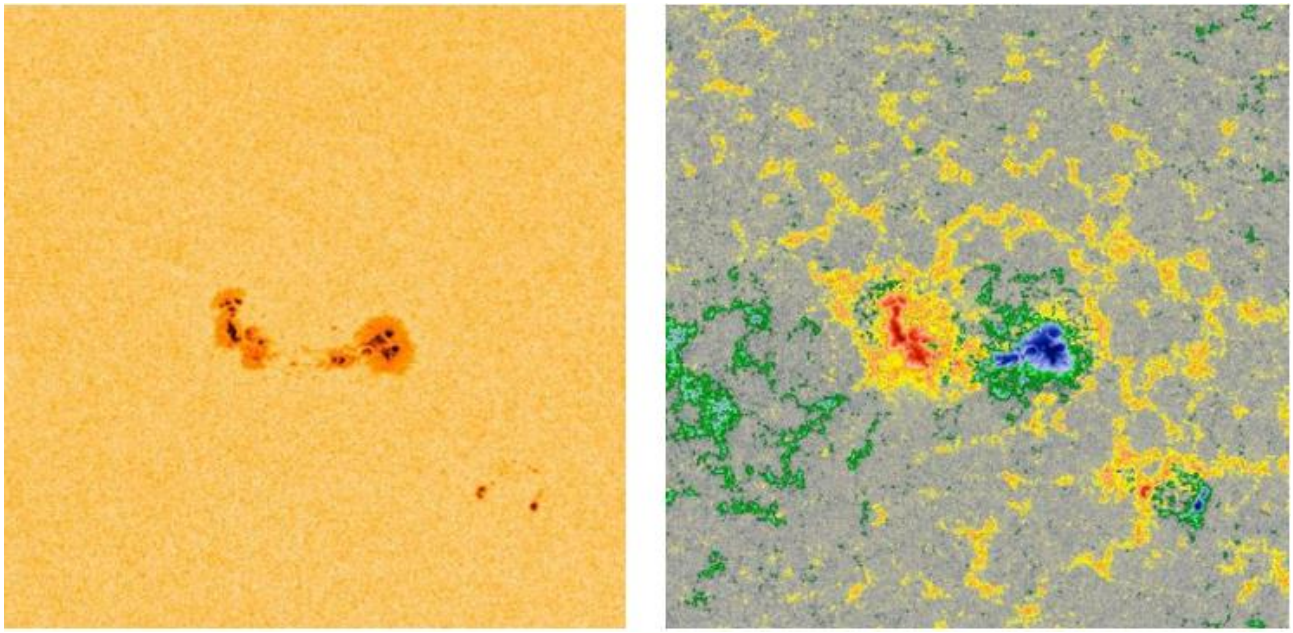
Figure 3: SDO/HMI magnetogram flat (left) and magnetogram color (right) for AR3407



Solar Radiation Storms - (High Energy Protons):

The flux of high energy (greater than 10 MeV) is at Background. Some of the more complex sunspot regions are still some days away from the better-connecting western horizon, and in any case they have yet to produce significant flare activity. Because of the subdued current disc, barring any further development the proton flux is expected to remain at background.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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High Energy Electrons Event (≥ 2MeV):

In recent days the high energy (greater than 2 MeV) electron flux at GOES16 has been varying between Normal Background and diurnal peaks of High (above 1000pfu). However, on 16th August a diurnal peak of Moderate was observed and with the onset of two high-speed streams forecast on Day 1 and 2 (16th and 17th) any periods of High flux are considered very unlikely as electron counts at GEO are suppressed for a time.

Confidence in the intervening time period is perhaps a little lower relative to recent issues of this guidance - due to the uncertain timing and duration of the fast winds from CH33/+ and CH35/-. As stated, however, the chances of avoiding any high speed stream from trans-equatorial CH35 are considered very low. The extent of any rebound is therefore the main uncertainty for the forecast overall, rather than the timing, which is reasonably likely to take place later this working week. This should see fluence perhaps responding from late Day 3 (18th) and probably reaching diurnally High values once again. The coronal holes on the disc were present on last pass, but geometry changes serve to lower confidence in persistence, even in the absence of any complicating transient effects.

An overall and increasing Chance of Active electron fluence is indicated for late this UTC week, with an extremely low risk prior to this.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	20	40
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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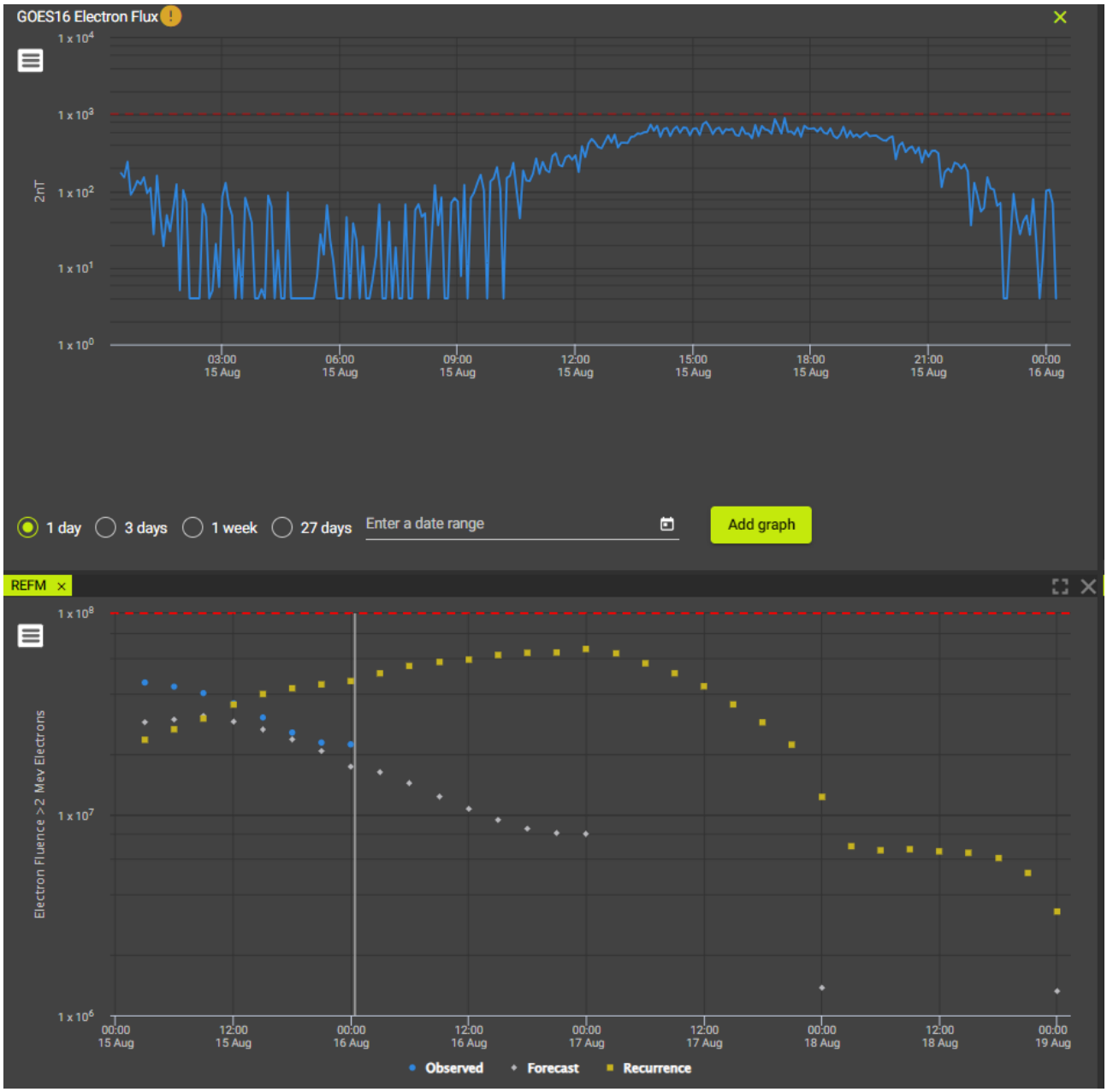
Figure 4: GOES16 >2MeV Electron Flux (top) and MOSWOC REFM and recurrence (bottom)



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